

This Page Is Inserted by IFW Operations
and is not a part of the Official Record

BEST AVAILABLE IMAGES

Defective images within this document are accurate representations of the original documents submitted by the applicant.

Defects in the images may include (but are not limited to):

- BLACK BORDERS
- TEXT CUT OFF AT TOP, BOTTOM OR SIDES
- FADED TEXT
- ILLEGIBLE TEXT
- SKEWED/SLANTED IMAGES
- COLORED PHOTOS
- BLACK OR VERY BLACK AND WHITE DARK PHOTOS
- GRAY SCALE DOCUMENTS

IMAGES ARE BEST AVAILABLE COPY.

**As rescanning documents *will not* correct images,
please do not report the images to the
Image Problems Mailbox.**

THIS PAGE BLANK (USPTO)

(5)

L1 1 08272095/PN
(JP08272095/PN)

=> diall

L1 ANSWER 1 OF 1 JAPIO COPYRIGHT 1999 JPO
ACCESSION NUMBER: 1996-272095 JAPIO
TITLE: COMPOSITION FOR SOLDERING PHOTORESIST INK
INVENTOR: SAITO MASAHARU; TSUKATANI TOSHIHIDE; MAKINO KIMIHIRO
PATENT ASSIGNEE(S): NIKKA CHEM CO LTD, JP (CO 330251)
PATENT INFORMATION:

PATENT NO	KIND	DATE	ERA	MAIN IPC

JP 08272095A	19961018	Heisei	(6)	G03F007-027

JP
APPLICATION INFORMATION
ST19N FORMAT: JP1995-96001 19950329
ORIGINAL: JP07096001 Heisei
SOURCE: PATENT ABSTRACTS OF JAPAN (CD-ROM), Unexamined
Applications, Vol. 96, No. 10
INT. PATENT CLASSIF.:
MAIN: (6) G03F007-027
SECONDARY: (6) C08F002-48; (6) C09D011-00; (6) C09D011-10; (6)
G03F007-028; (6) G03F007-032; (6) G03F007-035; (6)
H05K003-28

ABSTRACT:

PURPOSE: To provide compsn. having satisfactory dil. alkali developability, contg. a UV-curing resin having a long shelf life and giving a cured coating film excellent in adhesion, heat and moisture resistances and electric insulating property.
CONSTITUTION: In this compsn. contg. a UV-curing resin, a photopolymn. initiator, a diluent and a thermosetting resin, the UV-curing resin is obtd. by allowing a dibasic acid anhydride having a mol. wt. of .ltoreq.120 and a dibasic acid anhydride having a mol. wt. of .gtoreq.140 in a molar ratio of 1:9 to 9:1 to react simultaneously with a reactional product of a novolak type epoxy compd. with unsatd. mono- carboxylic acid.

THIS PAGE BLANK (USPTO)

L3 1 JP08272095/PN

=> d iall

L3 ANSWER 1 OF 1 CA COPYRIGHT 1999 ACS
ACCESSION NUMBER: 126:52861 CA
TITLE: Composition for solder photoresist ink
INVENTOR(S): Saito, Masaharu; Tsukatani, Toshihide; Makino, Kimihiro
PATENT ASSIGNEE(S): Nikka Chemical Ind Co Ltd, Japan
SOURCE: Jpn. Kokai Tokkyo Koho, 9 pp.
CODEN: JKXXAF
DOCUMENT TYPE: Patent
LANGUAGE: Japanese
INT. PATENT CLASSIF.:
MAIN: G03F007-027
SECONDARY: C08F002-48; C09D011-00; C09D011-10; G03F007-028; G03F007-032; G03F007-035; H05K003-28
CLASSIFICATION: 74-5 (Radiation Chemistry, Photochemistry, and Photographic and Other Reprographic Processes)
FAMILY ACC. NUM. COUNT: 1
PATENT INFORMATION:

PATENT NO.	KIND	DATE	APPLICATION NO.	DATE
JP 08272095	A2	19961018	JP 1995-96001	19950329 <--
JP 2937800	B2	19990823		

ABSTRACT:

The title compn. contains (A) a UV-curing resin prepd. by simultaneous reaction of a novolak-type epoxy compd.-unsatd. monocarboxylic acid reactant with a 1-9:9-1 mol ratio of 2 types of dibasic acid anhydrides with mol. wt. 120 and 140, resp., (B) a photopolymn. initiator, (C) a dilg. agent, and (D) a thermosetting resin. The compn. shows high shelf life and weak alkali-developability and good performance as a 1-liq. photoresist ink. Thus, an ink compn. comprising an UV-curing resin prepd. by reacting a cresol novolak-type epoxy resin-acrylic acid reactant with succinic anhydride and tetrahydrophthalic anhydride, Irgacure 907, Cayacure RETX-S (photopolymn. initiator), trimethylolpropane triacrylate, and YDCN-702S (cresol novolak-type epoxy resin) was prepd.

SUPPL. TERM: solder photoresist ink storage stability; one liq solder photoresist ink; UV curable solder photoresist ink; novolak epoxy resins photoresist ink; unsatd monocarboxylic acid epoxy resin; dibasic acid anhydride epoxy resin; thermosetting resin solder photoresist ink; heat resistance solder photoresist ink

INDEX TERM: Novolak epoxy resins
ROLE: IMF (Industrial manufacture); PEP (Physical, engineering or chemical process); POF (Polymer in formulation); TEM (Technical or engineered material use); PREP (Preparation); PROC (Process); USES (Uses)
(cresolic, reaction products with acrylic acid, succinic anhydride, and tetrahydrophthalic anhydride; one-liq. solder photoresist ink contg. acid-modified novolak epoxy resin with storage stability and heat resistance)

INDEX TERM: Photopolymerization catalysts
(in one-liq. solder photoresist ink contg. acid-modified novolak epoxy resin with storage stability and heat resistance)

INDEX TERM: Heat-resistant materials
Photoresists
(one-liq. solder photoresist ink contg. acid-modified novolak epoxy resin with storage stability and heat resistance)

INDEX TERM: 15625-89-5, Trimethylolpropane triacrylate

THIS PAGE BLANK (USPTO)

ROLE: PEP (Physical, engineering or chemical process); PROC (Process)
 (diluent; one-liq. solder photoresist ink contg. acid-modified novolak epoxy resin with storage stability and heat resistance)
 INDEX TERM: 148619-51-6, YDCN 702S
 ROLE: MOA (Modifier or additive use); USES (Uses)
 (in one-liq. solder photoresist ink contg. acid-modified novolak epoxy resin with storage stability and heat resistance)
 INDEX TERM: 79-10-7DP, Acrylic acid, reaction products with novolak epoxy resins, succinic anhydride, and tetrahydrophthalic anhydride 85-43-8DP, Tetrahydrophthalic anhydride, reaction products with novolak epoxy resins, acrylic acid, and succinic anhydride 108-30-5DP, Succinic anhydride, reaction products with novolak epoxy resins, acrylic acid, and tetrahydrophthalic anhydride 826-62-0DP, Endomethylenetetrahydrophthalic anhydride, reaction products with novolak epoxy resins, acrylic acid, and succinic anhydride 26590-20-5DP, Methyltetrahydrophthalic anhydride, reaction products with novolak epoxy resins, acrylic acid, and succinic anhydride
 ROLE: IMF (Industrial manufacture); PEP (Physical, engineering or chemical process); POF (Polymer in formulation); TEM (Technical or engineered material use); PREP (Preparation); PROC (Process); USES (Uses)
 (one-liq. solder photoresist ink contg. acid-modified novolak epoxy resin with storage stability and heat resistance)
 INDEX TERM: 71868-10-5, Irgacure 907 162774-73-4, Kayacure DETX-S
 ROLE: CAT (Catalyst use); USES (Uses)
 (photopolymn. initiator; one-liq. solder photoresist ink contg. acid-modified novolak epoxy resin with storage stability and heat resistance)

THIS PAGE BLANK (USPTO)

1 JP08272095/PN

=> d iall

L5 ANSWER 1 OF 1 WPIDS COPYRIGHT 1999 DERWENT INFORMATION LTD
ACCESSION NUMBER: 1997-003129 [01] WPIDS
DOC. NO. NON-CPI: N1997-002713
DOC. NO. CPI: C1997-000881
TITLE: Compsn. for solder-photoresist ink - including UV-curing resin, photopolymerisation initiator, diluting agent, and thermally curable resin.
DERWENT CLASS: A21 A89 G02 G06 L03 P84 V04
PATENT ASSIGNEE(S): (NKKK) NIKKA KAGAKU KK
COUNTRY COUNT: 1
PATENT INFORMATION:

PATENT NO	KIND	DATE	WEEK	LA	PG	MAIN	IPC
JP 08272095	A	19961018	(199701)*		9	G03F007-027<---	
JP 2937800	B2	19990823	(199939)		10	G03F007-027	

APPLICATION DETAILS:

PATENT NO	KIND	APPLICATION	DATE
JP 08272095	A	JP 1995-96001	19950329
JP 2937800	B2	JP 1995-96001	19950329

FILING DETAILS:

PATENT NO	KIND	PATENT NO
JP 2937800	B2 Previous Publ.	JP 08272095

PRIORITY APPLN. INFO: JP 1995-96001 19950329

INT. PATENT CLASSIF.:

MAIN: G03F007-027
SECONDARY: C08F002-48; C09D011-00; C09D011-10; G03F007-028;
G03F007-032; G03F007-035; H05K003-28

BASIC ABSTRACT:

JP 08272095 A UPAB: 19970102

Compsn. includes UV-curing resin, photo-polymerisation initiator, diluting agent and thermally curable resin. The UV-curing resin is prepd. by making anhydrate of dibasic acid, having mol.wt. of at most 120, and one, having mol. wt. of at least 140, in molar ratio of 1/9-9/1, to react simultaneously with the reaction product of novolak type epoxy cpd. and unsaturated monocarbocyclic acid.

USE - The compsn. is useful as photoresist for solder mask for printed-circuit board, or photoresist for Cu etching in prepn. of printed circuit board, etc.

ADVANTAGE - The compsn. has excellent stability for storage without increasing in viscosity for long time, and has excellent photo-curing ability, developability with dilute alkaline soln. resistance for heat and humidity, and electric resistivity.

Dwg.0/0

FILE SEGMENT: CPI EPI GMPI

FIELD AVAILABILITY: AB

MANUAL CODES: CPI: A08-C01; A11-C02B; A12-E07A; A12-L02B2; G06-D06;
G06-F03C; G06-F03D; L03-H04E2; L03-H04E6
EPI: V04-R01A1; V04-R02R; V04-R03E; V04-R04A2

THIS PAGE BLANK (USPTO)



Nicca Chem.

日華化学

Japanese Patent Kokai (A) Hei 8-272095

[Title] Solder photoresist ink composition

[Claims]

1. A solder photoresist ink composition comprising an ultraviolet-setting resin, a photopolymerization initiator, a diluent and a thermosetting resin, characterized in that said ultraviolet-setting resin is a resin obtained by reacting a reaction product formed between a novolak type epoxy compound and an unsaturated monocarboxylic acid with a dibasic acid anhydride having a molecular weight of no more than 120 and a dibasic acid anhydride having a molecular weight of no less than 140 simultaneously at a proportion giving a molar ratio of 1/9 to 9/1.
2. The solder photoresist ink composition claimed in Claim 1, wherein the number of phenol nuclei in the novolak type epoxy compound is no less than 4 and no more than 8 on the average.
3. The solder photoresist ink composition claimed in Claim 1 or 2, wherein the epoxy group of the novolak type epoxy compound is reacted with an equivalent quantity of unsaturated monocarboxylic acid.
4. The solder photoresist ink composition claimed in Claims 1 to 3, wherein said ultraviolet-setting resin is obtained by reacting one mole of hydroxyl group in the

reaction product formed between a novolak type epoxy compound and an unsaturated monocarboxylic acid with 0.3 to 1.0 mole of dibasic acid anhydrides.

5. The solder photoresist ink composition claimed in Claims 1 to 4, wherein said ultraviolet-setting resin has a acid value of 40 to 100 mg KOH/g.

6. The solder photoresist ink composition claimed in Claims 1 to 5, wherein said photopolymerization initiator is compounded in an amount of 0.2 to 20.0 parts by weight per 100 parts by weight of the ultraviolet-setting resin.

7. The solder photoresist ink composition claimed in Claims 1 to 6, wherein said diluent is at least one member selected from organic solvents and photopolymerizable monomers and the quantity of said diluent is 30 to 200 parts by weight per 100 parts by weight of the ultraviolet-setting resin.

8. The solder photoresist ink composition claimed in Claims 1 to 7, wherein said thermosetting resin is a polymerizable compound having at least two functional groups and the quantity of said thermosetting resin is 5 to 60 parts by weight per 100 parts by weight of the ultraviolet-setting resin.

[Detailed Description of the Invention]

[Industrial Field of the Invention]

The present invention relates to a solder photoresist ink composition, and more particularly to a solder photoresist ink composition useful as a photoresist for solder mask of printed circuit boards, a copper-etching photoresist used for production of printed circuit boards or a letter ink-photosensitive resin for forming a pattern by light irradiation, which is good in storage stability, excellent in dilute alkali developability, and capable of giving a cured film excellent in heat resistance, electrical insulating property and moisture resistance.

[Prior Art]

At the present time, the solder resist of various printed circuit boards is shifting from the thermosetting liquid resist resin by screen printing and the dry film type resist resin to liquid solder photoresist ink of dilute alkali development type. As such solder photoresist ink composition, there are known two-pack type compositions in which a first liquid component comprising an ultraviolet-setting resin obtained by reacting a reaction product formed between a novolak type epoxy compound and an unsaturated monocarboxylic acid with a saturated or unsaturated polybasic acid anhydride, a photopolymerization initiator and a diluent and a second liquid component comprising an epoxy compound having two or more epoxy groups in one molecule as a thermosetting ingredient and a diluent are mixed together just before use (Japanese Patent Kokoku Hei 1-54390). By mixing the two liquids, there is obtained a solder photoresist ink composition. The composition is coated onto a printed circuit board substrate, the coating is temporarily dried to make the surface of coating tack-free, then the coating is exposed to infrared ray through a photomask, the unexposed portion is eliminated by development using a dilute alkaline aqueous solution, and the exposed portion is completely heat-cured by an additional heating. However, such prior ultraviolet-setting resins of dilute alkali development type are disadvantageous in that the resin has highly reactive unsaturated bonds and carboxyl groups due to which molecular weight increases in the course of storage and the shelf life is short. Further, a solder photoresist ink composition using such a resin is disadvantageous in that, since it contains highly reactive unsaturated bond, carboxyl group and photopolymerization initiator in one liquid phase, stability of the photoresist ink is low and pot life is short, even though the epoxy compound is mixed just before

use (two pack type) in order to suppress the rise in viscosity of ink. Further, if shelf life of ultraviolet-setting resin and pot life of photoresist ink are improved by selecting appropriate polybasic acid anhydride and photopolymerization initiator and changing their quantities, the important properties required of solder photoresist ink in the process of manufacture such as dilute alkali developability and photo-setting property are damaged and the performances of solder resist film such as heat resistance, electrical insulating property and moisture resistance are deteriorated, even though storage stability may be improved.

[Problem to be Solved by the Invention]

The present invention aims at improving the storage stability of prior ultraviolet-setting resins and alkali development type solder photoresist inks prepared therefrom. More concretely saying, the object of the present invention is to provide an ultraviolet-setting resin which shows no increase in viscosity for a long period of time, and a solder photoresist ink composition prepared by compounding the ultraviolet-setting resin with a photopolymerization initiator and a diluent which shows no increase in viscosity for a long period of time while maintaining excellent photosetting property, dilute alkali developability, heat resistance, moisture resistance and electrical insulating property.

[Means for Solving the Problem]

With the aim of solving the problem mentioned above, the present inventors conducted extensive studies. As a result, it was found that a composition containing an ultraviolet-setting resin obtained by reacting a reaction product formed between a novolak type epoxy compound and an unsaturated monocarboxylic acid with two or more dibasic acids simultaneously is excellent in storage stability and dilute alkali developability and the cured product thereof

has good mechanical and chemical properties. Based on this finding, the present invention was accomplished. Thus, the present invention provides:

- (1) a solder photoresist ink composition comprising an ultraviolet-setting resin, a photopolymerization initiator, a diluent and a thermosetting resin, characterized in that said ultraviolet-setting resin is a resin obtained by reacting a reaction product formed between a novolak type epoxy compound and an unsaturated monocarboxylic acid with a dibasic acid anhydride having a molecular weight of no more than 120 and a dibasic acid anhydride having a molecular weight of no less than 140 simultaneously at a proportion giving a molar ratio of 1/9 to 9/1;
- (2). the solder photoresist ink composition of paragraph 1, wherein the number of phenol nuclei in the novolak type epoxy compound is no less than 4 and no more than 8 on the average;
- (3). the solder photoresist ink composition of paragraph 1 or 2, wherein the epoxy group of the novolak type epoxy compound is reacted with an equivalent quantity of unsaturated monocarboxylic acid;
- (4). the solder photoresist ink composition of paragraphs 1 to 3, wherein said ultraviolet-setting resin is obtained by reacting one mole of hydroxyl group in the reaction product formed between a novolak type epoxy compound and an unsaturated monocarboxylic acid with 0.3 to 1.0 mole of dibasic acid anhydride;
- (5). the solder photoresist ink composition of paragraphs 1 to 4, wherein said ultraviolet-setting resin has an acid value of 40 to 100 mg KOH/g;
- (6). the solder photoresist ink composition of paragraphs 1 to 5, wherein said photopolymerization initiator is compounded in an amount of 0.2 to 20.0 parts by weight per 100 parts by weight of the ultraviolet-setting resin;

(7). the solder photoresist ink composition of paragraphs 1 to 6, wherein said diluent is at least one member selected from organic solvents and photopolymerizable monomers and the quantity of said diluent is 30 to 200 parts by weight per 100 parts by weight of the ultraviolet-setting resin; and

(8). the solder photoresist ink composition of paragraphs 1 to 7, wherein said thermosetting resin is a polymerizable compound having at least two functional groups and the quantity of said thermosetting resin is 5 to 60 parts by weight per 100 parts by weight of the ultraviolet-setting resin.

The solder photoresist ink composition of the present invention comprises an ultraviolet-setting resin, a photopolymerization initiator, a diluent and a thermosetting resin. The ultraviolet-setting resin of the present invention is obtained by reacting a reaction product formed between a novolak type epoxy compound and an unsaturated monocarboxylic acid with a dibasic acid anhydride having a molecular weight of no more than 120 and a dibasic acid anhydride having a molecular weight of no less than 140 simultaneously at a molar ratio (between the two dibasic acid anhydrides) of 1/9 to 9/1. The novolak type epoxy compound is a polyfunctional epoxy compound obtained by reacting phenol or o-cresol with formaldehyde to obtain a phenol novolak or cresol novolak and then reacting the phenol novolak or cresol novolak with epichlorohydrin. Preferred among such novolak type epoxy compounds are those having no less than 4 and no more than 8 phenol nuclei on the average and having an epoxy equivalent of 170 to 230. If the number of phenol nuclei is less than 4, cured product of solder photoresist ink composition is brittle. If the number of phenol nuclei is greater than 8, dilute alkali developability and pot life of solder photoresist ink composition can be unsatisfactory. In the present invention, a novolak type

epoxy compound is reacted with an unsaturated monocarboxylic acid. By the reaction between epoxy group and carboxyl group, the oxirane ring opens to form an ester linkage and a hydroxyl group. The unsaturated monocarboxylic acids which can be used are not particularly limited, and acrylic acid, methacrylic acid, crotonic acid, vinylacetic acid, sorbic acid, cinnamic acid and the like can be used. Of these unsaturated monocarboxylic acids, acrylic acid is especially preferred, because it gives a cured product excellent in polymerizability and its cured product has excellent properties. The method for reacting the novolak type epoxy compound and the unsaturated monocarboxylic acid is not particularly limited. For instance, a novolak type epoxy compound and an unsaturated monocarboxylic acid may be heated in an appropriate solvent, whereby the aimed reaction can be made to progress. The diluents which can be used include ketones such as methyl ethyl ketone, cyclohexanone and the like; aromatic hydrocarbons such as toluene, xylene and the like; alcohols such as methanol, isopropanol, cyclohexanol and the like; alicyclic hydrocarbons such as cyclohexane, methylcyclohexane and the like; petrolic solvents such as petroleum ether, petroleum naphtha and the like; cellosolves such as cellosolve, butyl cellosolve and the like; carbitols such as carbitol, butyl carbitol and the like; and acetic esters such as ethyl acetate, butyl acetate, cellosolve acetate, butyl cellosolve acetate, carbitol acetate, butyl carbitol acetate and the like.

In the present invention, it is preferable that the quantity of unsaturated monocarboxylic acid is equivalent to the quantity of epoxy group in the novolak type epoxy compound reacted therewith. Both in a case where the quantity of epoxy group is excessive and in a case where the quantity of unsaturated monocarboxylic acid is excessive, storage stability is low and properties of cured product are

not good. The temperature of the reaction between novolak type epoxy compound and unsaturated monocarboxylic acid is preferably 90-200°C, and further preferably 100-130°C. In the practice of the reaction, the total quantity of novolak type epoxy compound and unsaturated monocarboxylic acid is preferably 20-80% by weight of the quantity of the reaction mixture consisting of novolak type epoxy compound, unsaturated monocarboxylic acid and diluent. The reaction product formed between novolak type epoxy compound and unsaturated monocarboxylic acid may be directly used, without isolation, for the subsequent reaction with dibasic acid anhydrides in the state of a solution in the diluent. The ultraviolet-setting resin used in the present invention is obtained by simultaneously reacting the reaction product formed between novolak type epoxy compound and unsaturated monocarboxylic acid with a dibasic acid anhydride having a molecular weight of no more than 120 and a dibasic acid anhydride having a molecular weight of no less than 140 under a condition that the molar ratio between the two dibasic acid anhydrides is in the range of from 1/9 to 9/1. As the dibasic acid anhydrides, saturated dibasic acid anhydrides and unsaturated dibasic acid anhydrides can be used. The dibasic acid anhydrides of which molecular weight is no more than 120 include succinic anhydride, methylsuccinic anhydride, glutaric anhydride, maleic anhydride, itaconic anhydride, glutaconic anhydride, citraconic anhydride, diglycolic acid anhydride and the like, of which succinic anhydride is particularly preferred. The dibasic acid anhydrides of which molecular weight is no less than 140 include allylsuccinic anhydride, phthalic anhydride, tetrahydrophthalic anhydride, hexahydrophthalic anhydride, methyltetrahydrophthalic anhydride, methylhexahydrophthalic anhydride, endomethylenetetrahydrophthalic anhydride, methylenendomethylenetetrahydrophthalic anhydride, methyl-

butenyltetrahydrophthalic anhydride, diphenic anhydride, nitrophthalic anhydride, phthalonic anhydride and the like. Of these acid anhydrides of which molecular weight is no less than 140, tetrahydrophthalic anhydride, methyltetrahydrophthalic anhydride and endomethylenetetrahydrophthalic anhydride are particularly preferred.

The dibasic acid anhydride reacts with the hydroxyl group of the reaction product formed between novolak type epoxy compound and unsaturated monocarboxylic acid to form an ester linkage and a free carboxyl group. The state of the resulting free carboxyl group and the state of bonding of the carboxyl and the main chain skeleton exercise a great influence upon dilute alkali developability, storage stability and properties of cured coating film. An ultraviolet-setting resin having good performances can be obtained by simultaneously reacting the dibasic acid anhydride having a molecular weight of no more than 120 and the dibasic acid anhydride having a molecular weight of no less than 140 under a condition that the molar ratio between the two dibasic acid anhydrides falls in the range of from 1/9 to 9/1 and preferably 3/7 to 7/3. If the proportion of the dibasic acid anhydride having a molecular weight of no more than 120 is smaller than the range mentioned above, dilute alkali developability can be insufficient. If the ratio of the dibasic acid anhydride having a molecular weight of no more than 120 to the dibasic acid anhydride having a molecular weight of no less than 140 is greater than 9/1 and the proportion of the dibasic acid anhydride having a molecular weight of no less than 140 is too small, there is a possibility that the coating film cannot exhibit good properties. A dibasic acid anhydride having a smaller molecular weight has a relatively small pKa value when linked to the main chain of reaction product, so that it has an effect of contributing to improvement of dilute alkali

developability. On the other hand, a dibasic acid anhydride having a higher molecular weight has a relatively high pKa value, so that it has an effect of contributing to good electrical properties and heat resistance when linked to the main chain.

It is important to ultraviolet-setting resin of the present invention that it is produced by a simultaneous addition of two kinds of dibasic acid anhydrides different in molecular weight from each other to a reaction product formed between novolak type epoxy compound and unsaturated monocarboxylic acid. A photoresist ink composition containing an ultraviolet-setting resin which has been formed in this manner exhibits an excellent storage stability and good performances as a solder photoresist ink (i.e. photo-setting property, dilute alkali developability, heat resistance, electrical insulating property and moisture resistance) simultaneously, and especially it has a good dilute alkali developability and a good thermosetting property. When three or more kinds of dibasic acid anhydrides are mixed together and reacted, the resulting composition is still good in storage stability and dilute alkali developability so far as the above-mentioned compounding ratio is fulfilled. However, if one of the two kinds of dibasic acid anhydrides is reacted with novolak type epoxy compound and the other dibasic acid anhydride is reacted with unsaturated monocarboxylic acid and the reaction products thus formed are mixed together afterwards, the composition thus obtained cannot exhibit good storage stability and good dilute alkali developability simultaneously, and thermosetting property is also inferior. That is to say, the effect of the present invention cannot be exhibited in a case where the two dibasic acid anhydrides are successively reacted with the reaction product formed between novolak type epoxy compound and unsaturated monocarboxylic

acid. Further, the effect of the present invention cannot be exhibited also in a case where the reaction product formed between novolak type epoxy compound and unsaturated monocarboxylic acid is reacted with a dibasic acid anhydride having a molecular weight of no more than 120 to obtain the first resin, and the reaction product formed between novolak type epoxy compound and unsaturated monocarboxylic acid is reacted with a dibasic acid having a molecular weight of no less than 140 to obtain the second resin, and finally the first and second resins are mixed together afterwards. Although the mechanism is unknown, the inventors consider that a simultaneous reaction of the two dibasic acid anhydrides leads to formation of carboxyl groups different in chemical environment in one ultraviolet-setting resin molecule, which makes it possible to exhibit the excellent performances of the present invention which are impossible to exhibit by a reaction of single dibasic acid anhydride.

In the production of the ultraviolet-setting resin used in the present invention, one kind of dibasic acid anhydride having a molecular weight of no more than 120 can be used, and two kinds of such dibasic acid anhydride may also be used in combination, if desired. Similarly, one kind of dibasic acid anhydride having a molecular weight of no less than 140 can be used, and two kinds of such dibasic acid anhydride may also be used in combination, if desired. Even if the number of dibasic acid anhydride increases, such a mixture of dibasic acid anhydrides can be used in the composition of the present invention so far as the molar ratio between dibasic acid anhydrides having a molecular weight of no more than 120 and dibasic acid anhydrides having a molecular weight of no less than 140 is in the range of 1/9 to 9/1. The quantity of dibasic acid anhydrides to be reacted with the reaction product formed between novolak type epoxy compound and unsaturated monocarboxylic acid is

preferably 0.3 to 1.0 mole per mole of the hydroxyl group in the reaction product formed between novolak type epoxy compound and unsaturated monocarboxylic acid. If the quantity of the dibasic acid anhydride reacted is less than 0.3 mole per mole of hydroxyl group in the reaction product formed between novolak type epoxy compound and unsaturated monocarboxylic acid, dilute alkali developability and properties of coating film can be deteriorated. If the quantity of the dibasic acid anhydride reacted is more than 1.0 mole on the same basis as above, unreacted dibasic acid anhydride remains in the reaction mixture to deteriorate the properties of cured coating film.

In the ultraviolet-setting resin of the present invention, the dibasic acid anhydride having a molecular weight of no more than 120 and the dibasic acid anhydride having a molecular weight of no less than 140 are simultaneously added to the reaction product formed between novolak type epoxy compound and unsaturated monocarboxylic acid and reacted. When the reaction product formed between novolak type epoxy compound and unsaturated monocarboxylic acid exists as a solution in a diluent, a mixture of the dibasic acid anhydrides is added to the solution, and heated and dissolved and reacted, whereby the reaction can be made to progress smoothly. The temperature at which the reaction product formed between novolak type epoxy compound and unsaturated monocarboxylic acid is reacted with the dibasic acid anhydrides is preferably 60-120°C, and further preferably 70-100°C. The ultraviolet-setting resin used in the present invention preferably has an acid value of 40-100 mg KOH/g. The acid value of the ultraviolet-setting resin can easily be controlled by appropriately selecting the quantity of dibasic acid anhydride to be reacted. If acid value of the ultraviolet-setting resin is lower than 40 mg

KOH/g, dilute alkali developability of the resist composition and adhesiveness and heat resistance of the cured coating film can be inferior. If acid value of the ultraviolet-setting resin is higher than 100 mg KOH/g, heat resistance, moisture resistance and electrical insulating property of the cured coating film can be inferior. The solder photoresist ink composition of the present invention contains a photopolymerization initiator. The photopolymerization initiator is not particularly limited, but one member or a combination of two or members selected from known ones which can decompose and generate radicals upon irradiation of light, such as benzoin, benzophenone, acetophenone, anthraquinone, xanthone, thioxanthone and ketal, can be used. Examples of such photopolymerization initiator include α -isopropoxy- α -phenylacetophenone, α,α -dimethoxy- α -phenylacetophenone, α,α -diethoxyacetophenone, trimethylbenzoyl phosphine oxide, 1-phenyl-1,2-propanedione-2-o-benzoyl oxime, 1-phenyl-1,2-propanedione-2-o-ethoxycarbonyl oxime and the like. These photopolymerization initiators can be used in combination with known photopolymerization accelerators such as benzoic acids, tertiary amines and the like. The quantity of the photopolymerization initiator is preferably 0.2-20.0 parts by weight and further preferably 2.0-10.0 parts by weight per 100 parts by weight of ultraviolet-setting resin. If the quantity of photopolymerization initiator is less than 0.2 part by weight per 100 parts by weight of ultraviolet-setting resin, the solder photoresist ink composition can be cured only by a long-term exposure to light. If the quantity of photopolymerization initiator is larger than 20.0 parts by weight per 100 parts by weight of ultraviolet-setting resin, properties of coating film thereof can be unsatisfactory.

The solder photoresist ink composition of the present invention contains a diluent. As the diluent, organic

solvents or photopolymerizable monomers can be used. When an organic solvent is to be used as the diluent, the diluent used in the reaction between novolak type epoxy compound and unsaturated monocarboxylic acid or in the synthesis of ultraviolet-setting resin by reaction of dibasic acid anhydride may be used as it is as the diluent for solder photoresist ink composition. If desired, an organic solvent may be additionally added in order to adjust the concentration of composition appropriately. On the other hand, the photopolymerizable monomer is preferably compounded into the composition after synthesis of ultraviolet-setting resin, because many of the photopolymerizable monomers have an ability of taking part in a thermal polymerization at the same time. Examples of the photopolymerizable monomer usable include monofunctional acrylate compounds such as methyl (meth)acrylate, ethyl (meth)acrylate, n-propyl (meth)acrylate, n-butyl (meth)acrylate, 2-ethylhexyl (meth)acrylate, lauryl (meth)acrylate, stearyl (meth)acrylate, cyclohexyl (meth)acrylate, phenoxy-ethyl (meth)acrylate, 2-ethoxyethyl (meth)acrylate, 2-butoxyethyl (meth)acrylate, glycidyl (meth)acrylate, 2-hydroxyethyl (meth)acrylate, 2-hydroxypropyl (meth)acrylate, benzyl (meth)acrylate, ethyleneglycol mono(meth)acrylate, ethylcarbitol (meth)acrylate and the like; and polyfunctional acrylates such as ethyleneglycol di(meth)acrylate, poly-ethyleneglycol di(meth)acrylate, neopentylglycol di(meth)acrylate, trimethylolpropane di(meth)acrylate, trimethylolpropane tri(meth)acrylate, glycerin diglycidyl ether di(meth)acrylate, glycerin triglycidyl ether tri(meth)acrylate, pentaerythritol tri(meth)acrylate, pentaerythritol tetra(meth)acrylate, dipentaerythritol penta(meth)acrylate, dipentaerythritol hexa(meth)acrylate, polyfunctional epoxyacrylates, and the like. In the description presented

above, the term "(meth)acrylate" inclusively means "acrylate and methacrylate"

In the solder photoresist ink composition of the present invention, the quantity of the diluent constituted of organic solvents or photopolymerizable monomers is preferably 30-200 parts by weight per 100 parts by weight of ultraviolet-setting resin. An organic solvent is used not only as a solvent at the time of synthesizing an ultraviolet-setting resin but also at the time of making a film by coating a solder photoresist ink composition onto a printed circuit board substrate and drying it. A photopolymerizable monomer is used not only for the purpose of diluting the solder photo-resist ink composition and thereby adjusting viscosity of the composition to a value facilitating the coating work but also for the purpose of accelerating the photopolymerization. If the quantity of the diluent is less than 30 parts by weight per 100 parts by weight of ultraviolet-setting resin, viscosity of solder photoresist ink composition is very high and the coating work onto printed circuit board substrate is difficult to practice. If the viscosity of diluent is larger than 200 parts by weight per 100 parts by weight of ultraviolet-setting resin, viscosity of the solder photoresist ink composition is very low and its coating work is difficult to practice. Further, when the diluent is an organic solvent, viscosity of the solder photoresist ink composition is too low and the work for drying the composition to a tack-free state is much time-consuming; while when the diluent is a photopolymerizable monomer, properties of the cured coating film are not good.

The solder photoresist ink composition of the present invention contains a thermosetting resin. The thermosetting resins blocks the carboxyl group remaining in the ultraviolet-setting resin and improves the adhesiveness, heat resistance, electrical insulating property and moisture

resistance which are indispensable performances of a solder resist. As the thermosetting resin, known epoxy resins and urethane resins having a functionality of no less than 2 can be used, of which those having a functionality of no less than 4 and no more than 8 on the average are especially preferred. In the solder photoresist ink composition of the present invention, the thermosetting resin is used preferably in an amount of 5-60 parts by weight and further preferably 10-40 parts by weight per 100 parts by weight of ultraviolet-setting resin. If the quantity of thermosetting resin is less than 5 parts by weight per 100 parts by weight of the ultraviolet-setting resin, adhesiveness and heat resistance of cured film are not good. If the quantity of thermosetting resin is larger than 60 parts by weight per 100 parts by weight of ultraviolet-setting resin, the dilute alkali developability is not good. In order to accelerate the thermal curing reaction of the thermosetting resin, known curing accelerator such as imidazoles, amines, carboxylic acids, phenols, quaternary ammonium salts, methylol group-containing compounds and the like may be used. In the preparation of the solder photoresist ink composition of the present invention, thermosetting resin is compounded preferably just before coating the composition onto a printed circuit board substrate, for the purpose of preventing the increase of viscosity and the decrease of developability.

If necessary, known fillers such as barium sulfate, silicon oxide and the like, known coloring pigments such as Phthalocyanine Green, Phthalocyanine Blue, titanium dioxide, carbon black and the like, various additives such as antifoaming agent, levelling agent and the like, and known polymerization inhibitors such as hydroquinone, hydroquinone monomethyl ether, pyrogallol, t-butylcatechol and the like may be incorporated into the solder photoresist ink composition of the present invention. The method for

applying the solder photoresist ink composition of the present invention is not particularly limited. For instance, the solder photoresist ink composition is coated onto whole surface of printed circuit board substrate by screen printing method, roll coater method, spray method or curtain coater method, dried at 65-80°C until the surface tackiness has disappeared, contacted with a photomask to mask the unnecessary portions, photocured, then treated with a dilute aqueous solution of alkali to dissolve off the unexposed portions, and finally thermally cured to obtain a cured coating film of solder resist. The light source used for photocure of the solder photoresist ink composition of the present invention may be any of the known light sources. For instance, lower pressure mercury lamp, medium pressure mercury lamp, high pressure mercury lamp, super-high pressure mercury lamp, xenon lamp, metal halide lamp and the like can be used for this purpose.

[Examples]

Next, the present invention is explained in more detail by referring to examples. The invention is by no means limited by these examples. Shelf life of ultraviolet-setting resin and developability and coating performance of composition were evaluated by the following methods.

(1) Accelerated shelf life test of ultraviolet-setting resin

An ultraviolet-setting resin was introduced into a capped plastic bottle and dipped in a thermostatted bath kept at 60°C. The duration (days) from the start of test to the time when viscosity at 25°C has reached a viscosity 2.5 times as high as the initial viscosity or the time when the viscosity at 25°C exceeded 1,000 poises was measured.

(2) Dilute alkali developability

In the process of producing a printed circuit board substrate for test, sample was cured by light irradiation and

then developed with 1% (by weight) aqueous solution of sodium carbonate at 20°C with stirring using a stirrer, and developability was evaluated according to the following criterion:

⊙: Developable in one minute or less; ○: Developable in more than 1 minute to 3 minutes; Δ: Developable in more than 3 minutes to 5 minutes; ×: Undevelopable within 5 minutes. Further, in order to evaluate developability of solder photoresist ink in a temporarily dried state, sample was temporarily dried at 75°C for 30 minutes and developability was evaluated just after the temporary drying and 3 days after the temporary drying.

(3) Adhesiveness

According to JIS K 5400 8.5.2, checker-wise cross cuts (10 longitudinal and 10 lateral) were formed on a printed circuit board substrate for test, a peeling test was carried out with cellophane tape, and the state of peeling after the test was visually examined.

⊙: 100/100 (no peeling noticeable at all); ○: 100/100 (slight peeling noticeable at side of lines); Δ: 90/100 to 99/100; ×: 0/100 to 89/100.

(4) Pencil hardness

According to JIS K 5400 8.4.2, pencil hardness was expressed by the highest hardness (H number) of Mitsubishi Uni pencil giving no injury on coating film.

(5) Solder heat resistance test

A printed circuit board substrate for test was coated with a rosin type flux (trade name GX-7, manufactured by Asahi Kagaku Kenkyusho), floated on a solder bath for 15 seconds kept at 260°C so that the coating surface was in contact with solder, and examined for swelling and peeling of coating film. This was taken as one cycle, and evaluation

was carried out by referring to total period of time required for occurrence of swelling or peeling.

(6) Resistance to water-soluble flux

Printed circuit board substrate for test was coated with a water-soluble flux (trade name CF-350, manufactured by LONCO Co.), floated on a solder bath kept at 260°C for 5 seconds so that the coating surface was in contact with solder, and then dipped in water kept at 60°C for 15 minutes. Then, a peeling test using cellophane tape was carried out. At the same time, the change in surface gloss and especially the state of whitening was visually examined.

Peeling test ⊙: No peeling noticeable at all; ○: Slight peeling noticeable; Δ: 10-30% of whole area was peeled; ×: 31% or more of whole area was peeled.

Whitening test ⊙: No whitening noticeable at all; ○: Slight whitening noticeable; Δ: 10-30% of whole area whitened; ×: 31% or more of whole area was whitened.

(7) Electrical insulating property test

According to JIS Z 3197, a printed circuit board substrate for test was examined for initial insulating property and insulating property after standing at 60°C, RH 90% for 500 hours, using SM-8210 (manufactured by Toa Dempa). The result was expressed in terms of one minute value at DC500V.

Production Example 1 (Production of ultraviolet-setting resin)

A one-liter separable flask equipped with a stirrer, a reflux condenser, a dropping funnel and a thermometer was charged with 190 g of ethyl carbitol acetate and 215 g of a cresol novolak epoxy resin having an epoxy equivalent of 215 and containing six phenol nuclei on the average per one molecule. With stirring, the content of the flask was heated up to 120°C, and 72 g (1.0 mole) of acrylic acid was dropwise

added from the dropping funnel while maintaining the temperature of 120°C over one hour, after which the reaction was continued for an additional 10 hours at 120°C. The reaction mixture was once cooled to room temperature, 20 g (0.2 mole) of succinic anhydride and 46 g (0.3 mole) of tetrahydrophthalic anhydride were added, and the resulting mixture was again heated to 80°C and reacted for 3 hours. After the reaction, the reaction mixture was cooled to room temperature, and there was obtained a viscous solution. The weight of residue upon heating of this solution was 65% by weight. In the state of solution, its acid value was 53 mg KOH/g. This solution is hereinafter referred to as Resin A-1.

Production Example 2 (Production of ultraviolet-setting resin)

The procedure of Production Example 1 was repeated, except that the ethylcarbitol acetate (190 g) used in Production Example 1 was replaced with 198 g of carbitol acetate and the 20 g of succinic anhydride and 46 g of tetrahydrophthalic anhydride were replaced with 30 g (0.3 mole) of succinic anhydride and 50 g (0.3 mole) of methyl-tetrahydrophthalic anhydride. The weight of residue upon heating of the viscous solution thus obtained was 65% by weight, and as a solution it showed an acid value of 60 mg KOH/g. This solution is hereinafter referred to as Resin A-2.

Production Example 3 (Production of ultraviolet-setting resin)

The procedure of Production Example 1 was repeated, except that the 188 g of ethylcarbitol acetate used in Production Example 1 was replaced with 195 g of butyl cellosolve and the 20 g of succinic anhydride and 46 g of tetraphthalic anhydride were replaced with 30 g (0.3 mole) of

succinic anhydride, 30 g (0.2 mole) of tetrahydrophthalic anhydride and 16 g (0.1 mole) of endomethylenetetrahydrophthalic anhydride. Weight of residue upon heating of the viscous solution thus obtained was 65% by weight, and acid value of the solution was 61 mg KOH/g. This solution is hereinafter referred to as Resin A-3.

Referential Example 1 (Production of ultraviolet-setting resin)

The procedure of Production Example 1 was repeated, except that ethylcarbitol acetate was used in an amount of 181 g and the combination of 25 g of succinic anhydride and 38 g of phthalic anhydride was replaced with 50 g (0.5 g) of succinic anhydride. The weight of residue upon heating of the viscous solution thus obtained was 65% by weight, and acid value of the solution was 57 mg KOH/g. This solution is hereinafter referred to as Resin A-4.

Referential Example 2 (Production of ultraviolet-setting resin)

The procedure of Production Example 1 was repeated, except that ethylcarbitol acetate was used in an amount of 195 g and the combination of 25 g of succinic anhydride and 38 g of tetrahydrophthalic anhydride was replaced with 76 g (0.5 mole) of tetrahydrophthalic anhydride. The weight of residue upon heating of the viscous solution thus obtained was 65% by weight, and acid value of the solution was 49 mg KOH/g. This solution is hereinafter referred to as Resin A-5.

Referential Example 3 (Production of ultraviolet-setting resin)

Resin A-4 and Resin A-5 were mixed together at a ratio of 1:1 by weight. The weight of residue of the viscous solution thus obtained was 65% by weight, and the mixed solution had an acid value of 53 mg KOH/g. This solution is hereinafter referred to as Resin A-6.

Resins A-1 to A-3 of Production Examples 1-3 and Resins A-4 to A-6 of Referential Examples 1-3 were subjected to an accelerated shelf life test. The results are shown in Table 2.

Example 1

Fifty five grams of ultraviolet-setting resin A-1, 3 g of photopolymerization initiator (Irgacure 907, manufactured by Ciba Geigy), 1 g of photopolymerization initiator (Cayacure DETX-S, manufactured by Nippon Kayaku), 5 g of trimethylolpropane triacrylate as a diluent, 0.5 g of imidazole type thermal curing agent (Nichigo Imidazole 2MI-AZ, manufactured by Nippon Gosei Kagaku K. K.), 3 g of Phthalocyanine Green pigment, 12 g of barium sulfate, 10 g of silicon oxide and 0.5 g of antifoaming agent (Foamlex SOL-30, manufactured by Nikka Kagaku K. K.) were compounded together. After kneading the compounded mixture by means of a triple roll mill, 10 g of a thermosetting resin (YDCN-7025, manufactured by Toto Kasei K. K., o-cresol novolak epoxy resin) was further mixed to prepare a solder photoresist ink composition. The composition thus obtained was coated by the method of screen printing on whole surfaces of two sheets of copper printed circuit board substrate on which pattern had previously been formed by etching, so as to give a film thickness of 15-20 μm . Then, the coated substrates were temporarily dried at 75°C for 30 minutes in a hot air circulation type oven. Just after the temporary drying, one of the substrates was contacted with a photomask and exposed to 500 mJ/cm^2 of ultraviolet ray projected from 3KW metal halide lamp to make progress a photocure. Then, the uncured portions of the coating film were eliminated by using 1% by weight solution of sodium carbonate as a developer. The developed substrate was further thermally cured at 150°C for 30 minutes to complete a printed circuit board substrate for

test. The other sheet of the test substrate was also temporarily dried and three days after exposed to ultraviolet ray under the same conditions as above, and developed with aqueous solution of sodium carbonate in the same manner as above, and heat-cured. Developability was evaluated just after the temporary drying and three days after the temporary drying. On the printed circuit board substrate for test which had been exposed and developed just after the temporary drying, properties of coating film were evaluated. The results are shown in Table 2.

Example 2

A printed circuit board substrate for test was prepared by repeating the procedure of Example 1, except that Resin A-2 was used as the ultraviolet-setting resin. Dilute alkali developability and properties of coating film were evaluated. The results are shown in Table 2.

Example 3

A printed circuit board substrate for test was prepared by repeating the procedure of Example 1, except that Resin A-3 was used as the ultraviolet-setting resin. Dilute alkali developability and properties of coating film were evaluated. The results are shown in Table 2.

Comparative Example 1

A printed circuit board substrate for test was prepared by repeating the procedure of Example 1, except that Resin A-4 was used as the ultraviolet-setting resin. Dilute alkali developability and properties of coating film were evaluated. The results are shown in Table 2.

Comparative Example 2

A printed circuit board substrate for test was prepared by repeating the procedure of Example 1, except that Resin A-5 was used as the ultraviolet-setting resin. Dilute alkali developability and properties of coating film were evaluated. The results are shown in Table 2.

Comparative Example 3

A printed circuit board substrate for test was prepared by repeating the procedure of Example 1, except that Resin A-6 was used as the ultraviolet-setting resin. Dilute alkali developability and properties of coating film were evaluated. The results are shown in Table 2.

Table 1

	Ex.1	Ex.2	Ex.3	C.Ex.1	C.Ex.2	C.Ex.3
Resin A-1	55	—	—	—	—	—
Resin A-2	—	55	—	—	—	—
Resin A-3	—	—	55	—	—	—
Resin A-4	—	—	—	55	—	—
Resin A-5	—	—	—	—	55	—
Resin A-6	—	—	—	—	—	55
Trimethylolpropane triacrylate	5	5	5	5	5	5
Irgacure-907 1)	3	3	3	3	3	3
Cayacure DETX-S 2)	1	1	1	1	1	1
Nichigo Imidazole2MI-AZ 3)	0.5	0.5	0.5	0.5	0.5	0.5
Phthalocyanine Green	3	3	3	3	3	3
Barium sulfate	12	12	12	12	12	12
Silicon oxide	10	10	10	10	10	10
Foamlex SOL-30 4)	0.5	0.5	0.5	0.5	0.5	0.5
YDCN-702S 5)	10	10	10	10	10	10

Notes: Ex.: Example; C.Ex.: Comparative Example

- 1) Photopolymerization initiator manufactured by Ciba Geigy
- 2) Photopolymerization initiator manufactured by Nippon Kayaku
- 3) Imidazole type thermal curing agent manufactured by Nippon Gosei Kagaku
- 4) Antifoaming agent manufactured by Nikka Kagaku
- 5) o-Cresol novolak type epoxy resin manufactured by Toto Kasei

Table 2

		Ex.1	Ex.2	Ex.3	C.Ex.1	C.Ex.2	C.Ex.3
Accelerated shelf life test (days)		45	45	45	15	45	20
Developability	Just after temporary drying	⊙	⊙	⊙	⊙	Δ	Δ
	3 days after temporary drying	⊙	○	○	×	×	×
Properties of coating film	Adhesiveness	⊙	⊙	⊙	⊙	⊙	○
	Pencil hardness	6H	6H	7H	7H	6H	5H
	Solder heat resistance (seconds)	60	60	75	45	60	30
	Resistance to water-soluble flux						
	Peeling	○	⊙	⊙	Δ	○	Δ
	Whitening	○	○	○	×	○	Δ
Electrical insulation (Ω)	Initial	$>10^{13}$	$>10^{13}$	$>10^{13}$	10^{11}	$>10^{13}$	10^{11}
	After moistening	10^{13}	$>10^{13}$	$>10^{13}$	10^9	10^{12}	10^9

Notes: Ex.: Example; C.Ex.: Comparative Example

The ultraviolet-setting resins produced according to Production Examples 1, 2 and 3 are long in shelf life in the accelerated test, demonstrating that they are good in storage stability. On the other hand, the ultraviolet-setting resin of Referential Example 1 produced from succinic anhydride (MW 100) only and the ultraviolet-setting resin of Referential Example 3 produced from a compounded mixture of an ultraviolet-setting resin using succinic anhydride (MW 100) only and an ultraviolet-setting resin using tetrahydrophthalic anhydride (MW 152) only are short in shelf life in the accelerated test, indicating their inferiority in storage stability. The solder photoresist ink compositions of the present invention (Examples 1-3) are excellent in dilute alkali developability just after temporary drying and excellent or good in dilute alkali developability even 3 days after temporary drying. The coating films obtained from the solder photoresist ink compositions of the present invention (Examples 1-3) are excellent or good in all of adhesiveness, pencil hardness, solder heat resistance, resistance to water-soluble flux and electrical insulating property. On the other hand, the solder photoresist ink composition of Comparative Example 1 using an ultraviolet-setting resin produced from succinic anhydride (MW 100) only is not good in dilute alkali developability 3 days after temporary drying, and inferior in heat resistance, resistance to water-soluble flux and electrical insulating property. The solder photoresist ink composition of Comparative Example 2 using an ultraviolet-setting resin produced from tetrahydrophthalic anhydride (MW 152) only is inferior in dilute alkali developability. The solder photoresist ink composition of Comparative Example 3 using a mixture of an ultraviolet-setting resin produced from succinic anhydride only and an ultraviolet-setting resin produced from tetrahydrophthalic anhydride only is inferior in dilute alkali developability,

adhesiveness, solder heat resistance, resistance to water-soluble flux and electrical insulating property, although the ratio of succinic anhydride to tetrahydrophthalic anhydride in ultraviolet-setting resin falls in the scope of the present invention, because the two anhydrides have not been reacted simultaneously.

[Effect of the Invention]

The ultraviolet-setting resin used in the present invention has a long shelf life, and the solder photoresist ink composition of the present invention has a good dilute alkali developability. The cured film prepared from the solder photoresist ink composition of the present invention is excellent in adhesiveness, heat resistance, moisture resistance and electrical insulating property. Further, solder photoresist ink composition of the present invention maintains a good dilute alkali developability for a long period of time after it is coated on a printed circuit board substrate and temporarily dried. This makes it possible to interrupt the work after temporary drying in the manufacture of printed circuit board, and has an effect of greatly improving the efficiency of manufacture of printed circuit board when holiday is inserted into a series of manufacturing steps.

THIS PAGE BLANK (USPTO)